

UNCLASSIFIED

AD NUMBER
AD809298
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to U.S. Gov't. agencies only; Administrative/Operational Use; 24 FEB 1967. Other requests shall be referred to United States Coast Guard, Washington, DC.
AUTHORITY
USCG ltr, 22 Nov 1974

THIS PAGE IS UNCLASSIFIED

United States Coast Guard Office of Engineering

862602

FIELD TESTING AND DEVELOPMENT CENTER

REPORT NO. 456

PROJECT 3944/42/01

ELASTOMERIC A. F. SHEET, "NOFOUL" FOR BUOYS

24 FEBRUARY 1967

Releasable to Government
Agencies only



Washington, D.C.

20226



UNITED STATES COAST GUARD
FIELD TESTING AND DEVELOPMENT CENTER
TEST REPORT
PROJECT 3944/42/01
ELASTOMERIC A. F. SHEET, "NOFOUL" FOR BUOYS

By

C. CUTHRELL, CHBOSN W4
Project Officer
Field Testing and Development Center
Baltimore, Maryland 21226

Date: 24 FEBRUARY 1967

Submitted: R. W. WITTER, CDR, USCG
Commanding Officer
Field Testing and Development Center
Baltimore, Maryland 21226

Date: MAR 17 1967

Approved: A. H. SIEMENS, CDR, USCG
Chief, Testing and Development Division
Office of Engineering
U. S. Coast Guard Headquarters
Washington, D.C. 20226

Authority: Comdt(ETD) ltr 3944/42/01 serial 4772 of 27 July 1966

Neither this report nor any excerpts therefrom shall be used for advertising or sales promotion purposes without the written permission of the Office of Engineering, U. S. Coast Guard Headquarters, Washington, D.C. 20226

ABSTRACT

This report covers a step by step description of the procedures and techniques used by B. F. Goodrich Company Technicians in covering a 5 x 11 LR buoy body with an elastomeric antifoulant sheet rubber ("NOFOUL"). The "NOFOUL" covering was manufactured and the system of application developed by the B. F. Goodrich Company, Akron, Ohio. The marine growth foulfree life of the material is reported to be five years.

A list of the materials and equipment used and application times involved is included with the report. A photographic record of the operation is also included with the report.

TABLE OF CONTENTS

	Page
Frontispiece: -----	i
Title Page: -----	ii
Abstract: -----	iii
Table of Contents: -----	iv
1. Introduction: -----	1
2. "NOFOUL" Application - Task II: -----	1
3. Discussion: -----	4
4. Recommendations and Conclusions: -----	6
Appendix A (Test Data Sheet) -----	A-1
Appendix B (Photographs) -----	B-1

1. INTRODUCTION:

Background - The B. F. Goodrich Company has developed and produced an elastomeric antifoulant sheet rubber which is reported to have a long term marine growth frouflee life. The elastomeric sheets are made antifouling by introducing at some point in the manufacture a toxic agent which repels marine growth. The concentration of toxic agent in the antifouling cover is the major factor in determining the rate of loss of toxic agent from the surface. The loss rate of the toxic agent required to inhibit fouling and thickness of the material, determines the frouflee life of the material. A parallel B. F. Goodrich Company development program has produced a new marine adhesive system which should insure good rubber to metal underwater adhesion for the effective life of the antifouling sheets.

Under B. F. Goodrich Company Technical Proposal No. 1815-128 they agreed to cover two Coast Guard buoy bodies with "NOFOUL" toxic rubber, estimated to offer complete protection against marine fouling and corrosion for five or more years. Two 5 x 11 LR buoys were selected for this purpose.

The proposal was divided into three phases or tasks:

TASK I: Cover one 5x11 LR buoy at their Akron, Ohio plant to, (1) gain experience and (2) establish the most suitable field installation techniques.

TASK II: A B. F. Goodrich Company team to cover a 5x11 LR buoy at FT&DC to, (1) provide the Coast Guard with a demonstration of the techniques used, and (2) assess the problems encountered in field application

TASK III: In service evaluation tests of "NOFOUL" covered buoys in marine environment by the Coast Guard.

This report covers a step by step description of the procedures and techniques used in accomplishing Task II. Materials and equipment used and application times involved are listed in Appendix A. Photographs and sketches of the Task II operation are shown in Appendix B.

2. "NOFOUL" APPLICATION - TASK II:

a. Sandblasting and epoxy primer:

For Task II a new 5 x 11 LR buoy (Ser. No. 5LR-66-11) was selected to be covered with the "NOFOUL" sheet rubber. On the day operations were to commence, the buoy body was sandblasted clean of all rust and turned over to the B. F. Goodrich Company team for application of the Hydrolock 25 epoxy primer (similar to Devran 201).

The surface of the buoy was blown clear with air and washed with denatured alcohol to remove grit and moisture. The epoxy primer and accelerator were mixed in the normal 9:1 ratio and two coats applied to the buoy body as soon after sandblasting as practical. Drying time between coats was approximately one hour. The lower portion of the buoy was painted in alternate colors to (1) insure complete two-coat coverage and (2) attempt to show penetration of sand during the buffing of the primer after drying. After painting, the buoy was stored in the buoy yard for the standard four-day primer-cure time. No special precautions were necessary to protect against the weather during this period. The average dry film thickness of the two primer coats was 8-to-10 mils with some areas as light as 6 mils. See Figures 1 through 3.

b. Preparation of buoy and application of tie cement.

After the four-day primer-cure time, the buoy was moved to Field Testing and Development Center and positioned on planks as shown in Figure 4. In this position all areas could be reached by rolling the buoy by hand. An outdoor site was selected to simulate actual field conditions.

A portable sandblaster loaded with FL-70 silicon sand (very fine grit) was used to buff the primed buoy. This primer buffing operation is required to remove the oxidation sheen and need not remove over one mil; however, a greater removal is permissible as long as at least two mils remain. The two-color system used earlier with the epoxy primer made the buffing operation fairly simple in that the blaster could see when the last primer coat had been penetrated.

Because of the irregular shape of the counterweight, it was necessary to fill some areas to prevent bridging of the "NOFOUL" sheeting. Devcon A, a two-part mix which normally hardens in about one hour, was used to fill these areas. This material is rather expensive, approximately \$2.80 per pound which might prohibit its use where large areas are to be filled. About 25 pounds was used on this buoy and proved to be satisfactory. See Figures 5 through 9.

The buffed buoy was blown clear and washed down with denatured alcohol to remove grit and moisture. The entire buoy body was brush-coated with one coat of B. F. Goodrich Plastilock Adhesive No. 315 (Hydrolock 50) just as it came from the can. Since Plastilock No. 315 dries rapidly, no time was lost in rolling the buoy over to apply a coating to the bottom surface. This tie cement may be sprayed or brushed on.

c. Application of "NOFOUL"

For the Task II operation 80% of the stock was prepared in the factory. Preparation included cutting the stock to previously prepared patterns, buffing as required and wrapping each piece. The wrapping has a two-fold purpose in that it expedites handling and prevents premature loss of the antifouling agent during storage. On a normal production basis, 100% of the stock could be prepared for any given size buoy.

The sequence of pieces applied was as shown in Figures 10, FTDC Sketch No. 1-67. This is not critical and could be altered some if required by certain circumstances such as available stock, position of buoy, etc.

Both the stock and buoy were washed down with denatured alcohol and allowed to dry before application of cement. The washing was to clean the surface of oil, dust and any moisture which may have accumulated. The cement (BF Goodrich Code 5CS3655 Hydrolock 75) and its accelerator were supplied in pre-measured containers, then mixed as required. Mechanical mixing is recommended, but is not mandatory. The cement when mixed has a pot-life of eight hours, and for best results should be kept covered when not in use. Because the application was by sections, only the immediate buoy area and a section of stock was prepared at one time. One coat of cement was applied to both stock and buoy, then allowed to dry (approximately 20 minutes depending on weather conditions). The cement was applied by brush but a spray application is possible. See Figure No. 11. For best results the cement coats should be of uniform thickness since an excessive amount lengthens the drying time. After the cement surfaces were dry, the stock was covered with a sheet of polyfilm and rolled up, leaving sufficient amount of cemented area exposed to start operations. See Figures 12 and 13. The polyfilm was used to keep the stock from sticking to itself and prevent premature mating of the two surfaces.

An activating solvent, toluene, was used to activate the dried cement on both the stock and buoy surface prior to bonding. Since toluene evaporates rapidly only one or two square feet of area was activated at one time. This operation requires some skill or feel in that the surfaces should be tacky but not wet when bonded. If the cement dried before mating, the surfaces were reactivated by swiping with swabs and lint free rags dampened with toluene solvent. Using the proper stitches and rollers, all areas were "stitched" (rolled in a regular pattern to eliminate trapped air and insure good contact) before unrolling and activating another area. See Figure 14. Because of the wide stock and buoy contour, air was occasionally trapped and localized under the stock resulting in small blisters. Such entrapment will have no effect on the function of "NOFOUL" stock, but if removed will provide a better bond. A hypodermic needle was used to puncture and drain these blisters. The puncture mark was self sealing.

Premature mating of the tacky stock to the buoy surface created some problems in that when the two pieces were separated it lifted the cement from one or the other. When this happened new cement had to be applied, dried, then activated and rebonded. Since polyfilm will not adhere to the dry or tacky cement, it proved effective in eliminating this problem. See Figure 15.

The seam areas required some additional work. The initial ply had to be buffed, skived with a buffer, washed with alcohol and cemented as described earlier. See Figure 16. The sequence for bonding overlapping seams is shown in Figure 17, FT&DC Sketch 2-67.

3. DISCUSSION:

a. "NOFOUL" Neoprene Compound.

The material used to cover the Task II buoy was as follows:

<u>"NOFOUL" STOCK NO.</u>	<u>THICKNESS</u>	<u>APPROXIMATE % OF BUOY AREA COVERED</u>
443 A	80 mils	95%
900 A	80 mils	5%
443 A	40 mils	Stripping.

Stock No. 900A was used to cover area E and for stripping between A and C. (Refer to Figure 10, FT&DC Sketch 1-67.) Both stocks (900A and 443A) are basically the same except 900A has an additional antifouling agent which is expected to be beneficial. Stock 900A was also reported to be best for ease in preparation and application which could reduce application time over 443A.

Area J was buffed on the exposed side for better volatilization of the "NOFOUL" properties. See Figure 18. Better volatilization was thought to be necessary since this is the area that will be in and out of the water in service use. Fouling would normally be expected to occur first in this area.

Some dimensional differences were noted between the Task I and II buoys. The most noticeable being that the Task II buoy was 1-1/2 inches longer and was equipped with three lifting eyes in lieu of two. Since most of the stock was pre-cut at the Akron plant to patterns made for the smaller buoy, the stock had to be stretched to conform to the new dimensions and shapes. Pattern I was cut to accommodate the additional lifting eye and in stretching to conform to the larger dimension was inadvertently torn. The seam was irregular due to stretching and

was later stripped with 40 mil stock. See Figure 19. Figures 20 through 22 are additional photographs of the "NOFOUL" application.

Patching may be accomplished by buffing the damaged area and covering with a piece of stock material allowing for at least a one-inch overlap and bonding with chloroprene adhesive. Further primer and tie cement layers are not necessary where bonding is rubber to rubber. A small tear behind the counterweight of the Task II buoy was buffed out and repaired in this manner.

Removal of the antifouling sheet after toxic depletion was discussed with the B. F. Goodrich Technicians. The rubber coating may be removed by application of moderate heat, around 150°F, and stripping. This characteristic has been reportedly engineered into the adhesive for this purpose. A second consideration would be to sandblast the buoy clean of any fouling, which could be accomplished without rupturing or affecting the adhesive bond, and applying a second layer of "NOFOUL" directly over the first with the modified chloroprene adhesive. Further primer and tie cement layers would be unnecessary for this operation. This additional weight could create a problem since the true weight of one layer of the "NOFOUL" system is reported to be approximately 0.5 pounds per square foot, which would make a double layer near one pound.

Antifouling rubber as a health hazard was also discussed with the B. F. Goodrich Technicians. According to them, so far as can be determined, there is no health hazard. Antifouling rubber has been handled safely in their factory for over one year. Their information from independent biological concerns, the supplier of the toxic agent and their own toxicological tests indicate that the material can be handled safely without special precautions. No special precautions were taken at FT&DC other than the normal safety precautions connected with the handling of the paint, thinners and solvents. "NOFOUL" does have a very obnoxious odor before as well as after installation.

b. B. F. Goodrich Company Technical Personnel.

Most of the work accomplished in covering the Task II buoy was done by two B. F. Goodrich Company Product Technicians. These men were well experienced in handling and installing rubber products; having been employed by the company for over ten years. Neither of the two men had any special training for their jobs but relied mostly on past experience and a feel or desire for this kind of work. A. B.F. Goodrich Company Senior Product Engineer was also available one day during the installation operation to discuss procedures and techniques used and assist the Product Technicians as necessary. There is nothing connected with the application of "NOFOUL" covering that could not easily be taught our own technical or service personnel.

c. Weather Conditions:

Preparations of the Task II buoy and application of the "NOFOUL" sheet took place on 20 and 25 through 28 October 1966. Weather conditions during this period were as follows:

October 20:	windy	-	Temperature	40-50°F.	- high humidity
" 25:	-	-	"	40-60°F.	- intermittent showers
" 26:	-	-	"	40-70°F.	- sunny
" 27:	-	-	"	40-70°F.	- sunny
" 28:	windy	-	"	35-60°F.	- sunny

The weather during this period was not exactly ideal, however; it is typical for the area at this time of year.

4. RECOMMENDATIONS AND CONCLUSIONS:

- a. More evaluation on the use of Devcon A as a fill material.
- b. Two color system for epoxy primer with green to be used as a base color.
- c. Evaluate a shorter cure time for epoxy primer in connection with the "NOFOUL" system.
- d. Use electric in lieu of air-operated hand tools.
- e. Manufacturer to supply "NOFOUL" in kits, complete with all materials needed. Stock to be cut, buffed, including seam overlap, labeled and wrapped ready for use. This would reduce cost and eliminate waste. Patterns for every size or type buoy to be covered would be required.
- f. Manufacturer to supply installation instructions with each kit including any safety instructions necessary.

The most important thing stressed by the B. F. Goodrich Technicians was to follow the manufacturers instructions without taking short cuts or by-passing steps in the system. Some short cuts may be found later such as a shorter epoxy primer cure time which could reduce the overall cost of the system. Application of the "NOFOUL" system was not found to be beyond the capability of service or Depot personnel.

APPENDIX A

Test Data

A-1

TEST DATA SHEET

1. TASK II - "NOFOUL" Application Time:

<u>PROCEDURE</u>	<u>MAN HOURS</u>
Sand blast buoy	4.0
Epoxy primer (2 coats)	2.5
Prepare primed surface (blast-buffing)	2.0
Fill areas of counterweight with Devcon A and buff	6.0
Apply Plastilock 315 Hydrolock 50 (tie cement)	1.0
Prepare stock *	9.0
Application of stock	26.0
Buff seams	6.0

Total- 56.5 hours.

The man hours listed are the actual times two men spent in accomplishing the different procedures. This does not include time spent in preparation for work, time cost for weather, delays in material, etc.

*NOTE: The preparation of stock would normally be done in the factory and not in the field.

2. TASK II - Tools and Equipment Used:

Spraying Operation:

Spray gun - Binks Model #18, Nozzle #66 - Needle #15
Regulator - Binks #85-123
Pressure Pot - Binks #80-212 with 85-121 air pressure regulator
Respirator
Air line filter - Binks #86-124

Sandblast Epoxy Primer:

Portable sandblast unit
Hood and face shield

Cement and "NOFOUL" Application:

Paint brushes 3" - 4 each
Solvent can
Scissors - 5" blade

Straight edge - 3'
 Small buffer - Model 2L2700 (Thor)
 Large buffer - Model 3013L-18000 (Thor)
 Carborundum Silver Carbide Stone #111
 Wire wheel 3" diameter, 1" wide
 Abrasive cartridge rolls (for buffers) - 12 each
 Measuring tape - 8'
 Skiving knife - H-770 (Hyde)
 Mill knife handle BG-34 (Hyde)
 Mill knife blade 2607 (Hyde)
 Putty knife
 Narrow steel stitcher
 Flat steel stitcher - 1/4"
 Flat steel stitcher - 1"
 Rubber covered roller - 2"
 Hypodermic needle B18
 Marking pencil (silver ink)
 Lint free rags
 Lint free swabs - 4"
 Work tables 4' x 8' - 2 each

3. TASK II - Materials Used:

"NOFOUL" stock 443A - .080 gage	212 sq. ft.
"NOFOUL" stock 443A - .040 gage	3 sq. ft.
"NOFOUL" stock 900A - .080 gage	12 sq. ft.
Epoxy primer paint - Hydrolock 25	1.5 gal.
Plastilock 314 Hydrolock 50 (tie cement)	2 qt.
Devcon A (fill material)	25 lbs.
Polyethylene .006 smooth red	200 sq. ft.
Denatured alcohol (wash material)	1 gal.
Toluene/methyl isobutyl keton mixture (wash equipment)	1 gal.
Toluene (activating solvent)	1 gal.
Sandblast grit (FL-70 silicon sand - primer buffing)	150 lbs.
Hydrolock 75:	
BFG Code 5CS3655A - cement	2 gal.
BFG Code 5CS3655A - cement accelerator	1 qt.

APPENDIX B

Photographs

B-1

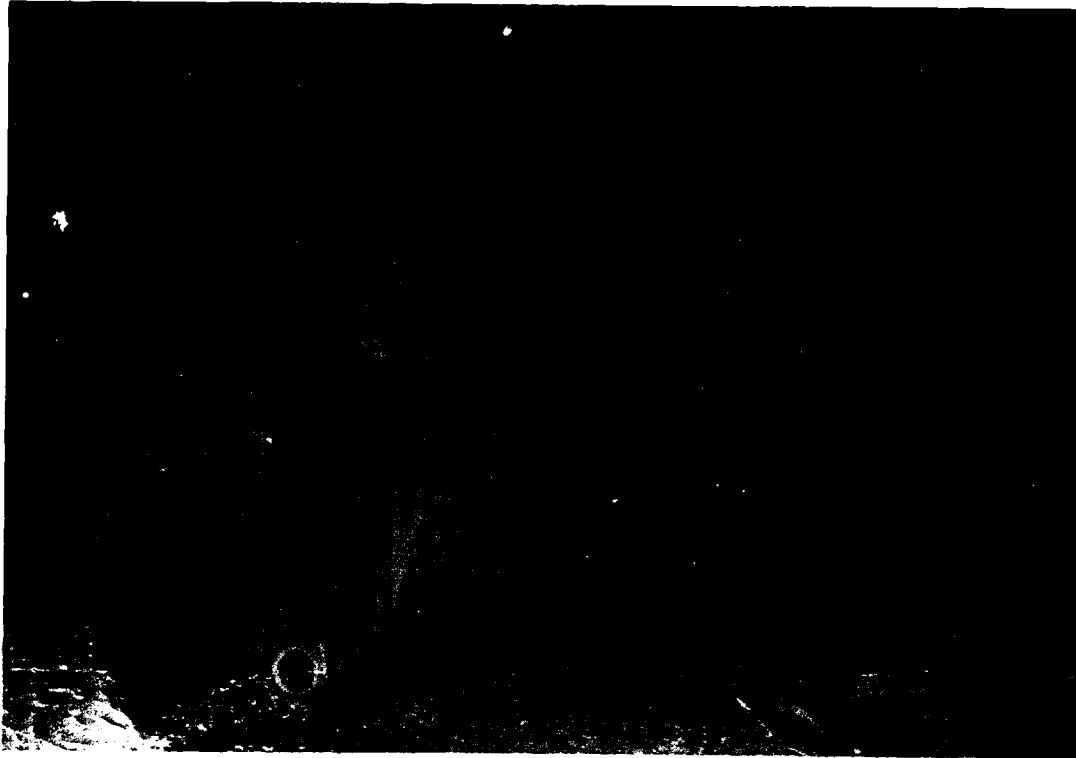


FIGURE 1 - 5x11 LR buoy sandblasted and ready
for primer coats.

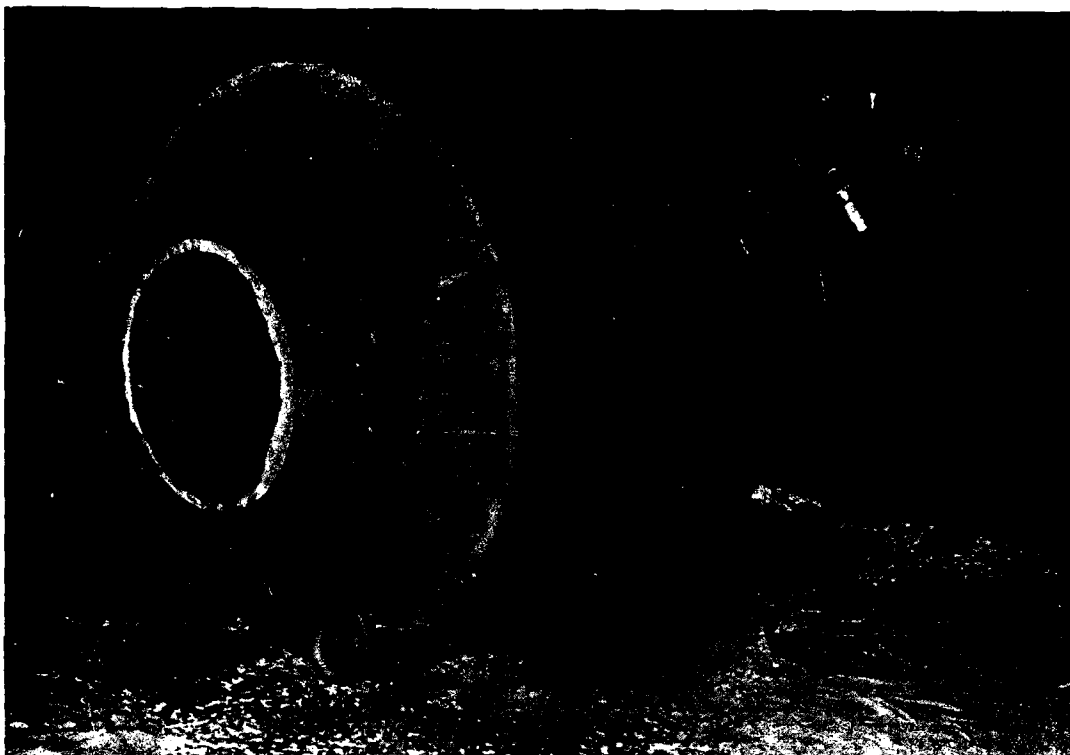


FIGURE 2 - 5x11 LR buoy - primer application.

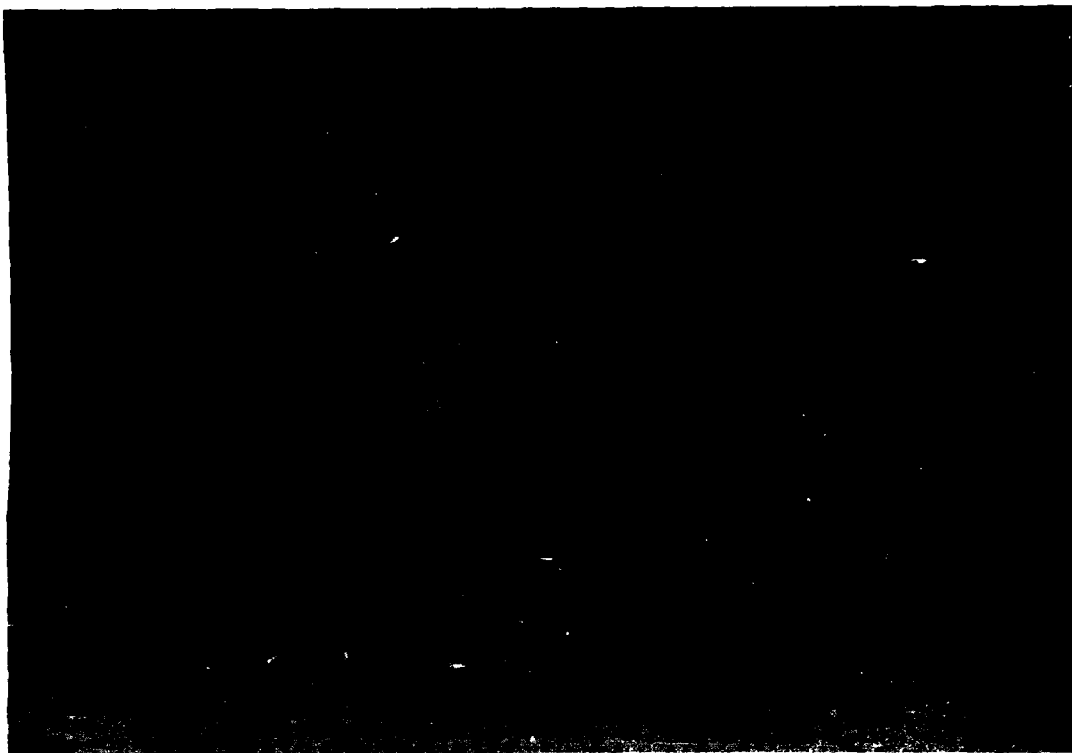


FIGURE 3 - 5x11 LR buoy primer application.

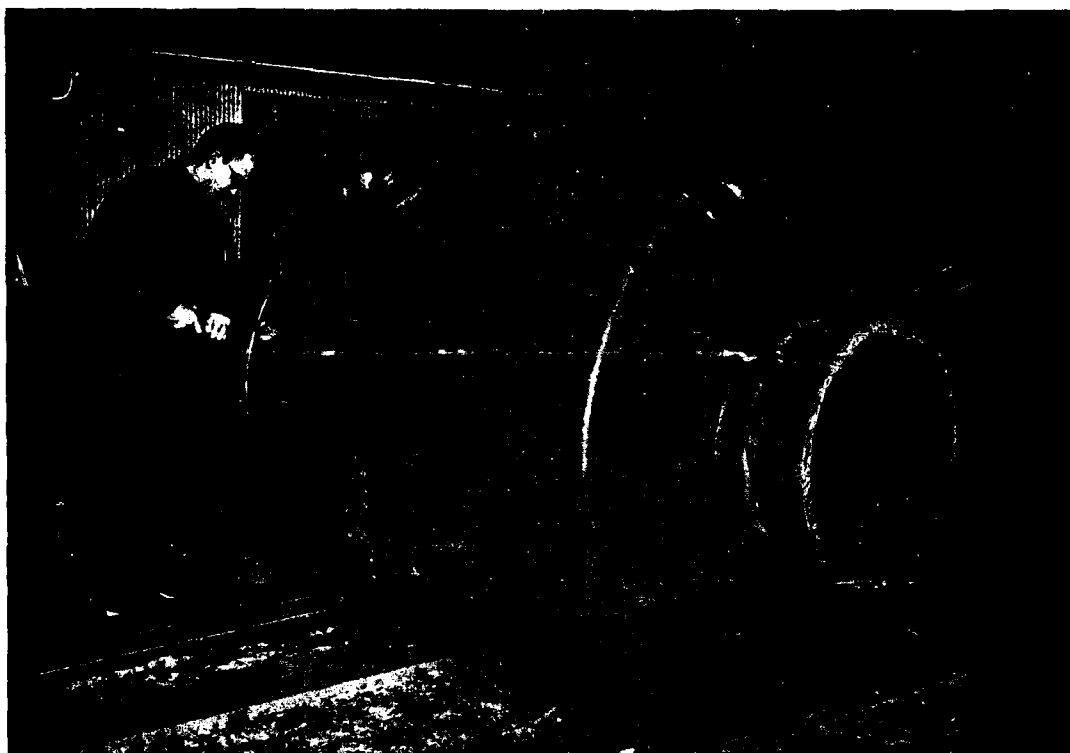


FIGURE 4 - 5x11 LR buoy - positioned on planks
for easy rotation by hand.



FIGURE 5 - Irregular shape of bottom of counter-weight required filling.

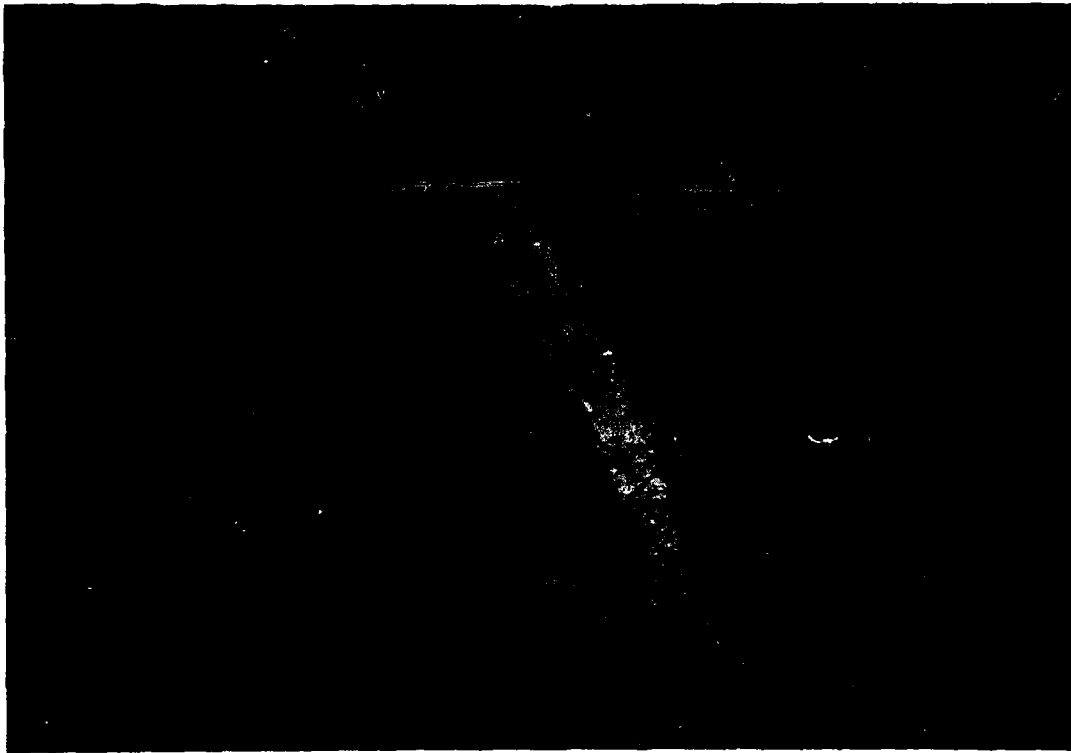


FIGURE 6 - Bottom of counterweight filled with
Devcon A.

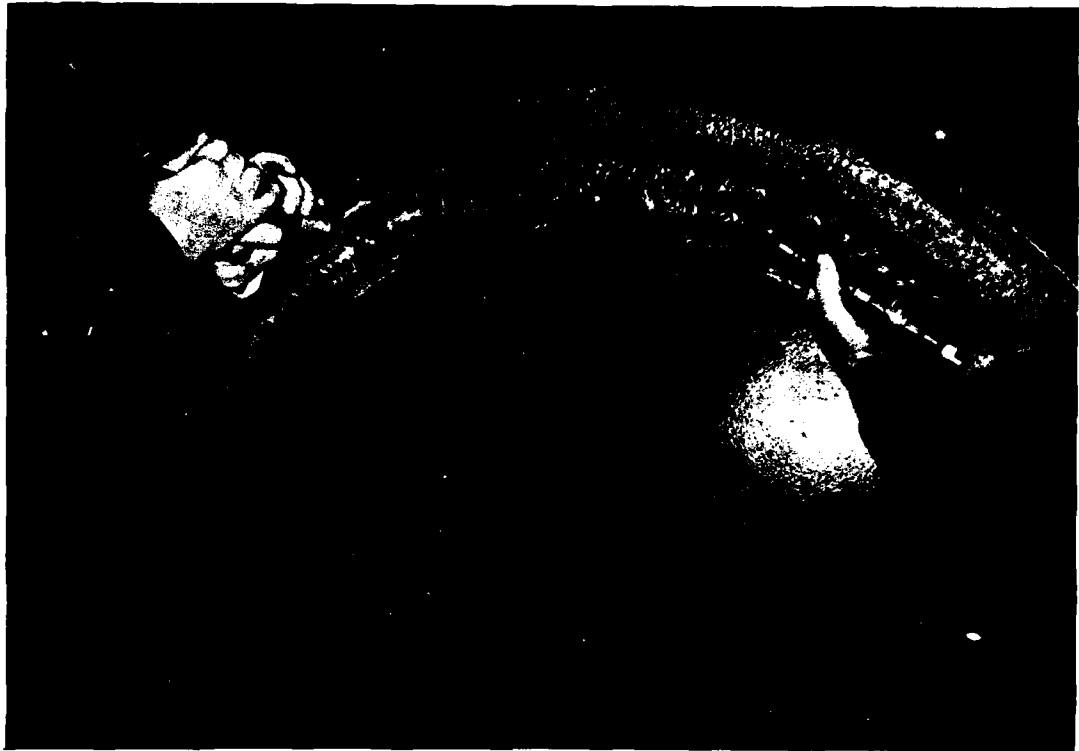


FIGURE 7 - Buffing hardened Devcon A.



FIGURE 8 - Area to be filled with Devcon A.

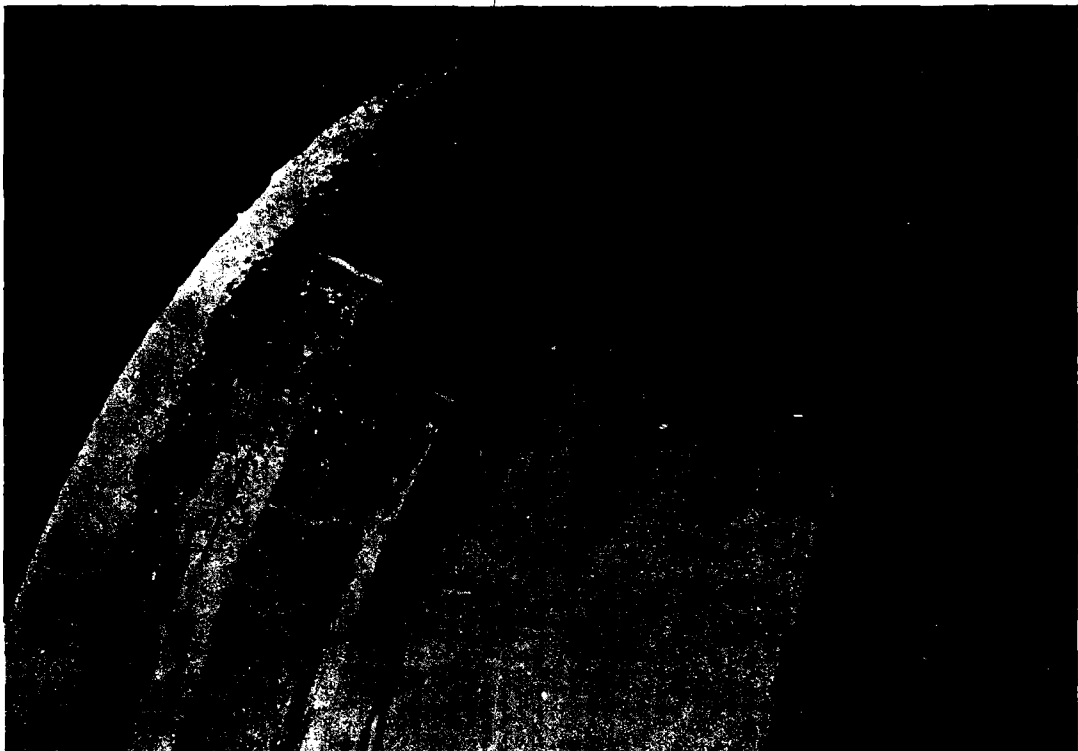
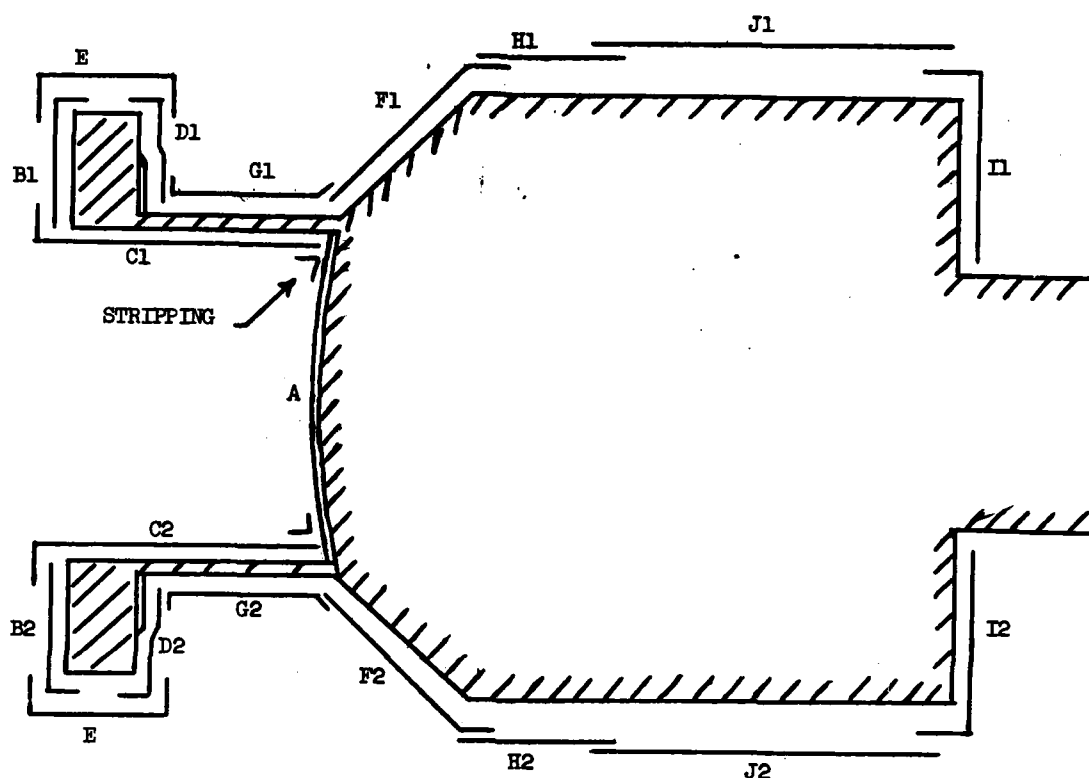


FIGURE 9 - Area filled with Devcon A.

PATTERN CODE



APPLICATION SEQUENCE

- | | |
|---------|----------------|
| 1 - I1 | 11 - J1 |
| 2 - I2 | 12 - B1 |
| 3 - F1 | 13 - B2 |
| 4 - F2 | 14 - G2 |
| 5 - D1 | 15 - J2 |
| 6 - A | 16 - C1 |
| 7 - H1 | 17 - C2 |
| 8 - H2 | 18 - E |
| 9 - D2 | 19 - STRIPPING |
| 10 - G1 | |

FIGURE 10

FTDC Sketch No. 1-67



FIGURE 11 - One panel with cement brushed on and drying.

B-12



FIGURE 12 - Stock rolled in polyfilm and ready
for application.

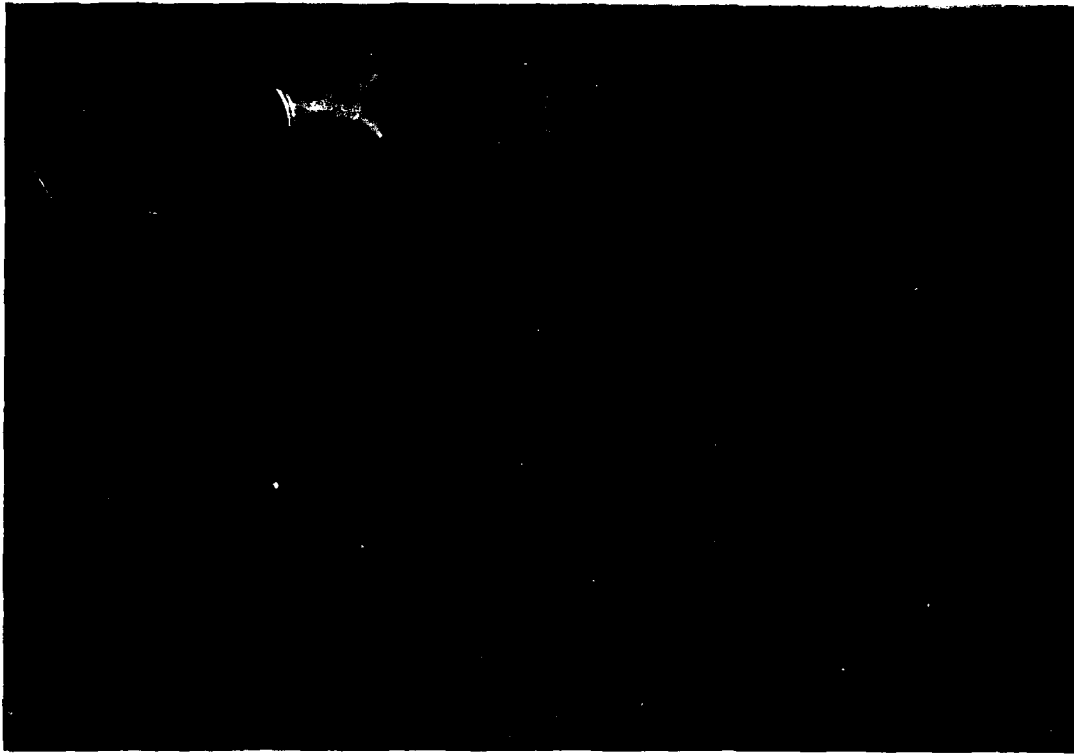


FIGURE 13 - Application of "NOFOUL" stock.



FIGURE 14 - Stitching to eliminate trapped air and insure good contact.



FIGURE 15 - Polyfilm protecting against premature mating of the surface.

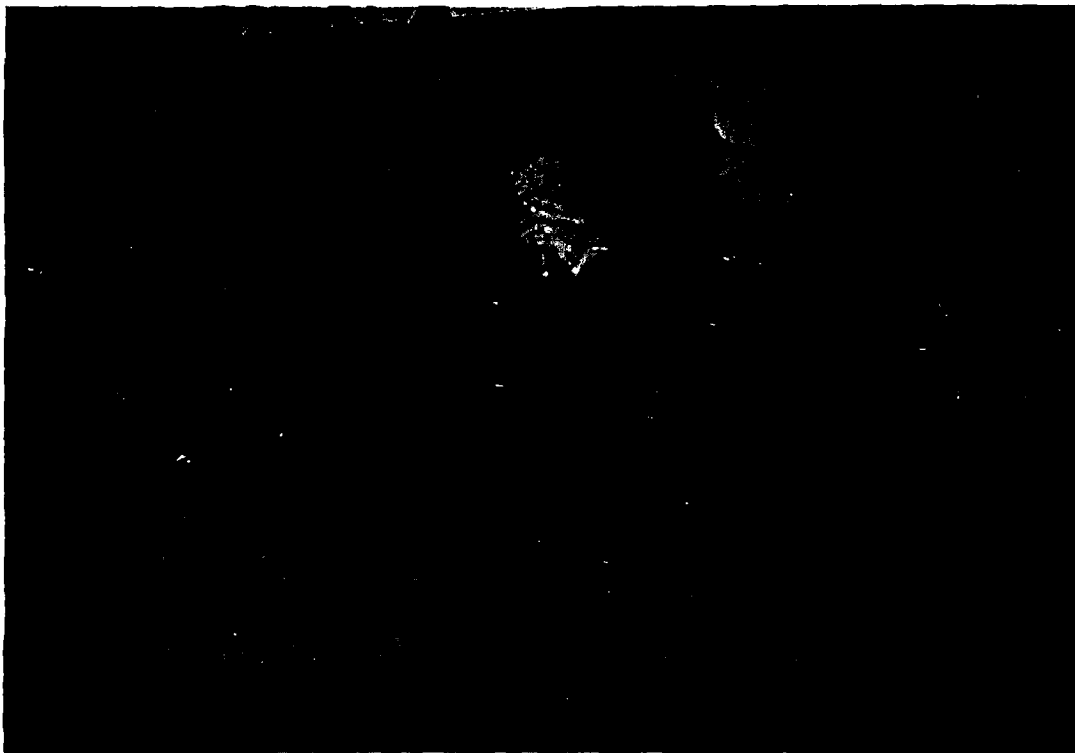
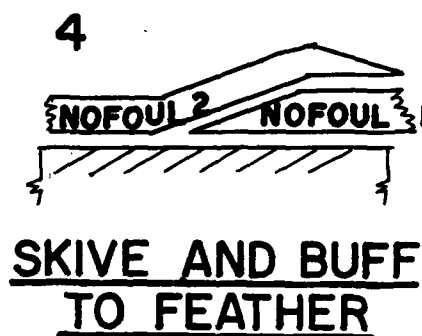
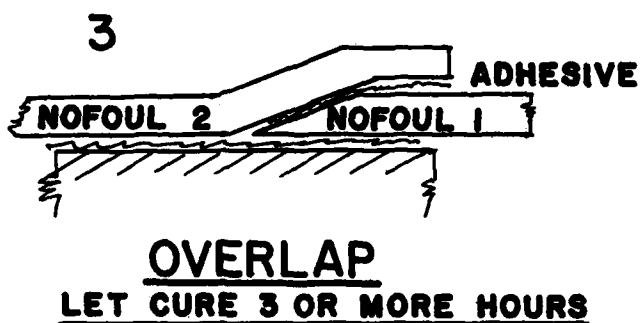
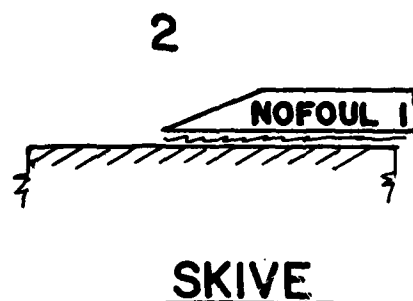
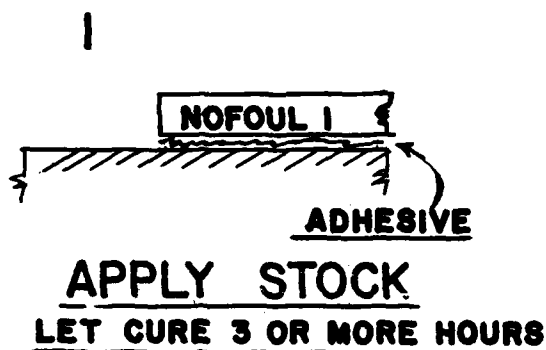


FIGURE 16 - Skiving a seam by buffing.



OVERLAPPED AND SKIVED SEAMS

FIGURE 17

FT & DC SKETCH
NO. 2/67

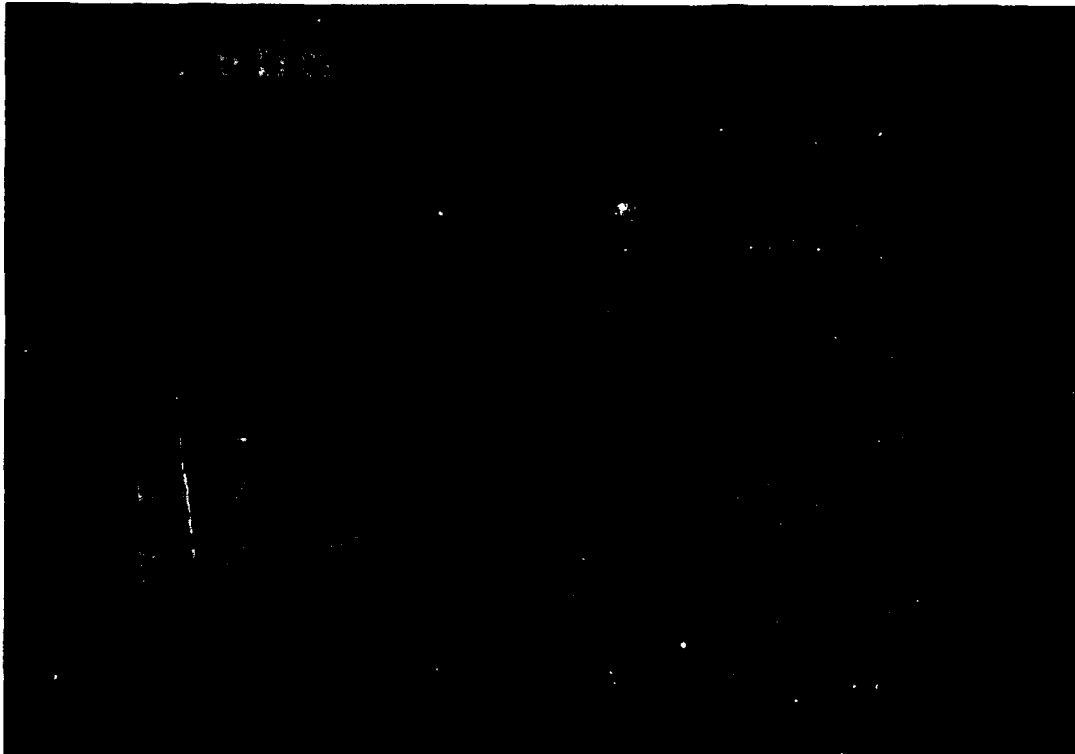


FIGURE 18 - Area J buffed on exposed side.

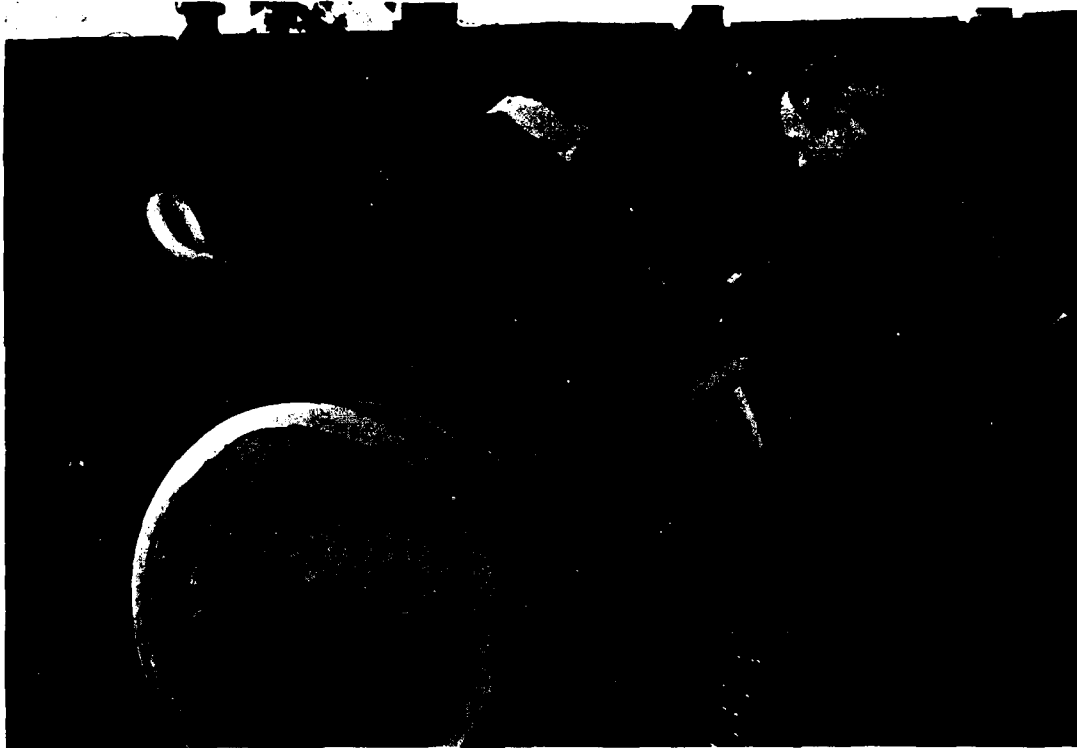


FIGURE 19 - Stripping in Section I.

B-20



FIGURE 20 - Note serial number visible after covering
with "NOFOUL"

B-21



FIGURE 21 - Stock preparation in the field

B-22



FIGURE 22 - Buoy completely covered with "NOFOUL"